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(54) **Fermentation of green tea**

(57) In fermenting green tea, the green tea is mixed with from 0.02 to 0.7 parts by weight of acid to every part by weight of green tea, the acid being selected such that the fermentation ensues at a pH of from 4.3 to 5.0. Sulphuric, orthophosphoric or acetic acid, an acetate buffer or a citric acid-phosphate buffer may used.

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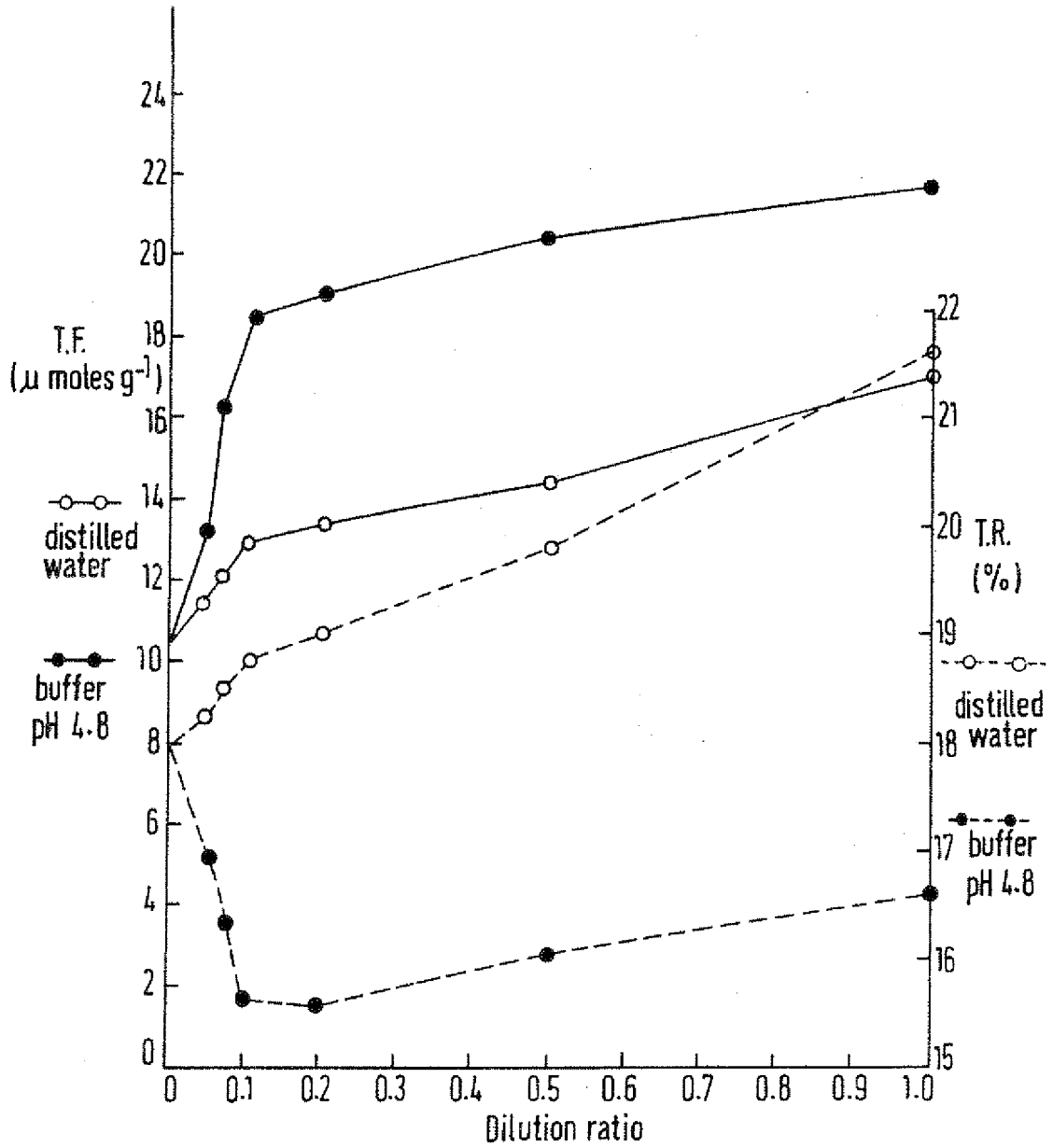
The drawing originally filed was informal and the print here reproduced is taken from a later filed formal copy.


T.F.
(μ moles g⁻¹)
distilled water
buffer pH 4.8
T.R.
(%)
distilled water
buffer pH 4.8
Dilution ratio
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
24
22
20
18
16
14
12
10
8
6
4
2
0
22
21
20
19
18
17
16
15

SPECIFICATION

Fermentation of green tea

The present invention relates to the fermentation of green tea.

The drink tea is prepared by addition of hot water to black tea itself manufactured from green tea by a fermentation procedure. For a conventional fermentation, green tea ie the harvested tea leaf and any associated plant material, is dried or withered and then macerated by rolling, cutting or other comminution procedure. The withered, macerated material or "dhool" thereupon undergoes the fermentation, which is principally a complex set of oxidation and related reactions resulting in formation of various chemical species which impart flavour, taste and aroma to the drink tea.

In US Patent No. 3,392,020 there is disclosed a process in which fresh green tea is fermented in aqueous suspension at a pH below the natural pH of such a suspension, and preferably at a pH in the range 3.7 to 4.5, in the presence of oxygen. It is said that the method is particularly useful for the preparation of fermented teas from which extracts, in powder or liquid form, may be prepared. Thus, for example, when the desired degree of fermentation has been reached, the suspension may be heated to extract the soluble matter and thereafter separated from the solid matter and concentrated. In this way tea extracts are obtained which can be added to conventional products or used in the other described ways.

In contrast to the use of a suspension as proposed in the US Patent, a process has now been found which uses less liquid and which is directed to improving the qualities of black tea itself, rather than any extract derived therefrom.

More specifically, in accordance with the present invention there is provided a process for fermenting green tea in which the green tea is mixed with from 0.02 to 0.7 parts by weight of acid to every part by weight of green tea, the acid being selected such that the fermentation ensues at a pH of from 4.3 to 5.0.

The present process is suitable for fermentation of the withered and macerated material known as "dhool", and readily results in a finished black tea which is preferred by tea tasters and assessors in preference to the black tea obtained from the dhool by conventional fermentation. There is also evidence that the present product has better storage characteristics.

The pH for a fermentation in accordance with the present invention is from 4.3 to 5.0, preferably from 4.5 to 4.8, and more preferably about 4.6. For any given variety of green tea the optimum pH can easily be determined by small-scale trials.

The nature of the acid used to effect the pH-modification of the invention is not unduly critical. For instance, the acid can be an inorganic acid eg. sulphuric acid or orthophosphoric acid or an organic acid eg. acetic acid. The acid can be employed alone, or as a buffer solution eg. Walpole's acetate buffer or McIlvaine's citric acid - phosphate buffer.

From 0.02 to 0.7 parts by weight of acid is employed for every part by weight of the green tea. A preferred acid : green tea weight ratio is from 0.05 to 0.2, with about 0.1 being especially preferred. For the ratio of about 0.1, we find that the preferred pH of from 4.5 to 4.8 is obtained using for example 0.1 M sulphuric acid, 0.33 M acetic acid or 0.2 M orthophosphoric acid.

Apart from the incorporation of the acid, the present process can be carried out in a manner similar to that employed for conventional fermentations. Air or other oxygen-containing gas can be passed through the fermenting material; for preference air is forced upwardly through the material. The fermentation can be monitored in known manner, and can be carried out in a batch or continuous manner. After the fermentation the material is driec to give the black tea : drying may also drive off volatile acids such as acetic acid, but removal of the added acid is not required in order to obtain a black tea with improved organoleptic and other qualities.

The present invention is illustrated by the following non-limiting examples.

In the examples, quantitative assessment of the fermentation of Central African teas is achieved by monitoring levels of theaflavins (TF) and thearubigins (TR), which are the principal classes of pigment present in the drink tea. TF content is generally associated with the "Briskness" and "Brightness" of tea liquor, and it has been established that the quantitative assessment of TF content is the best indicator of market value for Central Africans teas (J Sci Fd Agric, *23* (1972), 227 and ibid, *26* (1975) 1681). Some TR is also necessary in a tea infusion in order to give "colour" and "strength", but when TR is present in relatively large amounts, as in Central African teas, these pigments can obscure the expression of the desirable properties ocassioned in the presence of TF. The present objective is therefore to maximize TF production at the expensive of TR formation.

For determination of TF and TR contents, use was made of the standardized procedures which are given in Rep Tea Res Stn Blantyre, Tea Association of Central Africa, 1964 - 65, at page 50; J Sci Fd Agric, *23* (1972), 227; and Rep Tea Res Foundation Central Africa, 1972 - 73 at page 80.

Example 1

A laboratory procedure was devised which simulated the features of commercial manufacturing. Freshly harvested flushing shoots of a standard size and stage of development were selected. 10 such turgid shutes were weighed and then ground with twice their weight of fine, acid-treated sand in a pre-chilled pestle and mortar. During this period of tissue disruption, 3 ml of either citric acid - phosphate (McIlvaine's) or acetate (Walpole's) buffer of a pre-determined pH was added. After approximately 5 minutes the macerated suspension was transferred to a flask maintained at 25°C in a water bath. Fermentation in a stream of oxygen was thereafter allowed to proceed for 40 minutes before being terminated by the addition of boiling water. The resultant aqueous infusion was analysed directly for fermentation products.

The experiment was repeated on 5 occassions. Since there were no appreciable differences between the use of the two buffer systems, the results were pooled.

It was found that the maximum production of TF, about 40 μmoles/g, was obtained at a pH of between 4.7 and 4.8. The TF level fell away with increase or decrease in pH, with 34 μmoles/g being produced for a buffer pH of either about 4.5 or about 4.95.

On the other hand, in marked contrast to the TF/pH relationship, the production of TR and the development of total colour decreased continuously as the pH was lowered. At a pH of 4.7 the TR content was less than 70% of that at pH 5.6, while the total colour was reduced by about 25% for the same pH alteration.

Example 2

Using the procedure of example 1, the effect, if any, when using a different clone or variety of tea was assessed. It was found that the pH of maximum TF formation varied from 4.4 for clone MFS 76, to 4.8 for clone SFS 371. The magnitude of the TF increase also varied.

In general, it was found that the process of the present invention was effective for all the teas which were tried, including China hybrids and Indian hybrids.

Example 3

Proceeding in the same way as in example 1, the effect of dilution on the production of TF and TR was investigated. Volumes of buffer at pH 4.6 were added to the disrupted tea so that 6 different ratios of acid to tea were obtained. As controls, similar preparations were made by using the same volumes of distilled water instead of buffer.

The results are shown in Figure 1, where the continuous lines refer to TF production (left-hand scale) and the discontinuous lines refer to TR production (right-hand scale) and the open circles are for the control experiments using distilled water and the solid circles are for the experiments in accordance with the present invention using the buffer.

From the Figure 1 it will be seen that the presence of the buffer enhanced the formation of TF and appreciably reduced the formation of TR. It will also be seen that at the dilutions below about 0.1, the effects vary markedly with change in the dilution ratio, while at greater dilution ratios the effects tend to vary less with change in dilution. Bearing in mind the eventual need to dry the fermented material in order to obtain a black tea, it will be readily appreciated that the optimum dilution ratio was 0.1.

Example 4

For a small-scale manufacture, green tea harvested according to recommended commercial plucking practice was used. The tea was partially desiccated, ie. "withered", to about 70% of the fresh weight using a forced current of ambient air for a period of between 18 and 22 hours. The withered green tea was then fed into a rotorvane processing unit and then further comminuted by passing it through three conventional CTC machines arranged in series. As the dhool dropped out of the third CTC unit it encountered a countercurrent spray of buffer or acid at the required pH. 3 kg batches of withered leaf were so treated with precalibrated sprayers so that the desired acid to leaf ratio was obtained. The macerated material was then allowed to ferment for 60 minutes in rectangular troughs having mesh base plates, ambient air being forced through the leaf mass from beneath at a velocity of approximately 4 $m^3 min^{-1}$. Fermentation was thereafter terminated upon transfer of the dhool to a tray drier.

As with the process of example 1, it was found that the TF concentration varied with pH, reaching an optimum within the range specified for the method of the present invention. In practice, the TF level for a given pH was less than that obtained in example 1, reflecting the more drastic conditions employed in the simulated procedure of example 1. For this present example, the maximum TF production was about 23 μmoles/g at a pH of about 4.6. The percentage increase in TF content at pH 4.6 when compared with the level at pH 5.6 was of the same order of magnitude as the percentage increase obtained in example 1.

Samples of the black tea manufactured by this small scale procedure of the present were assessed by professional tea tasters in comparison with a directly comparable product obtained using the conventional fermentation procedure. Compared with the auction price predicted for the conventional product, the present black tea was expected to command a price some 30% higher.

Example 5

A pilot-scale procedure was then carried out. A commercial sample of standard green tea was given a 70% wither and processed in an LTP unit which uses the hammer mill principle and has a centrifugal fan to introduce and discharge leaf. 8 kg batches of comminuted leaf were collected in a pivotted metal drum, the drum rotated about its axis, and 800 ml of 0.2 M orthophosphoric acid was sprayed and mixed in with the dhool for 2 minutes. The treated material was then transferred to a continuous fermentation unit programmed to ferment for periods between 60 and 100 minutes. After fermentation the dhool was dried in a commercial drier.

The pilot-scale procedure was performed on six occasions using five different clonal teas. On each occasion, a directly comparable conventional manufacturing procedure was employed in which the orthophosphoric acid was omitted.

10 minutes after the addition of the orthophosphoric acid, the macerated green tea being treated in accordance with the present invention had a pH generally within the range of 4.5 to 4.9, whereas the pH of the comparable, control sample was within the range 5.2 to 5.7. The standard deviation from the mean pH value of the treated material determined on any one occasion was of the same order of magnitude as that for the corresponding control sample, indicating that the spraying process had achieved a uniform pH lowering.

It was found that the acid treatment consistently

resulted in marked increases in the TF levels, although the magnitude of the effect varied with clone and with manufacturing occasion. For example, the TF content of one clone was increased by amounts between 34 and 49%, whereas the increase for another clone was between 14 and 27%. The average increase in TF levels varied between 42% and 20% depending upon the clone.

The "binned" tea, that is the bulk of tea accumulated in a metal silo over the period (usually about 2 weeks) required to make up a commercial consignment, was found to have an improved quality (TF and total colour) when compared with the directly comparable, control material. The improvement in quality was corroborated by an evaluation of the "muster" performed by a tea broker, and by the estimated auction price for samples of the black tea. Upon further storage for a 5 to 7 month period, it was found that the TF and total colour levels had altered much less than with the conventional product.

Example 6

The procedure of example 4 was followed, but with monitoring of the TF production during the course of the fermentation. It was found that the rate of TF production was greater when using the acid, than when the fermentation was carried out in a conventional manner. In addition, the maximum TF level was also higher. For each fermentation the maximum was reached at around 50 minutes, and for the fermentation in accordance with the invention it was noticed that with prolonging of the fermentation beyond 50 minutes the TF level did not fall away as quickly as with the control products.

CLAIMS

1. A process for fermenting green tea in which the green tea is mixed with from 0.02 to 0.7 parts by weight of acid to every part by weight of green tea, the acid being selected such that the fermentation ensues at a pH of from 4.3 to 5.0.

2. A process according to Claim 1, in which the fermentation pH is from 4.5 to 4.8.

3. A process according to Claim 2, in which the fermentation pH is about 4.6.

4. A process according to any preceding claim, in which the acid is sulphuric acid, orthophosphoric acid, acetic acid or a buffered acid.

5. A process according to any preceding Claim, in which the acid : green tea weight ratio is from 0.05 to 0.2.

6. A process according to Claim 5, in which the said weight ratio is about 0.1.

7. A process according to any preceding Claim, in which air is forced upwardly through the fermenting material.

8. A process for fermenting green tea which process is substantially as described in any one of the Examples.

9. Fermented green tea produced by a process according to any preceding Claim.

10. Black tea produced by drying fermented green tea as defined in Claim 9.

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